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Clinical Evaluation of Radiographic Periodontal Attachment Loss using DSRIA Among Periodontal Disease Groups Before and After Periodontal Therapy

Guey-Lin Hou[1, 2]*

[1]*Former Professor, Graduate Institute of Dental Science, Department of Periodontics, Kaohsiung Medical University, Taiwan*

[2]*Former Professor and Chairman, Periodontal Prosthetics Center, Chang-Gung Memorial Hospital, Kaohsiung City, Taiwan*

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***Corresponding author:** Guey-Lin Hou, Former Professor, Graduate Institute of Dental Science, Department of Periodontics, Kaohsiung Medical University, Taiwan. E-mail: hougl2001@yahoo.com.tw

Abstract

The aim of the present study was to investigate the cumulative radiographic periodontal attachment loss (CRPAL) and annual radiographic periodontal attachment loss (ARPAL) of different disease groups over 5 years or more after after periodontal therapy using the Sandwich's technique. A total of 53 subjects, who had taken two sets of full-mouth standarlized paralleling radiographs with separated periods of 5 years or more in Kaohsiung Medical University Hospital during 1981- 2001, were collected for the past 20 years. The measurement of CRPAL and ARPAL at mesial and distal aspects of teeth were assessed by measuring the distance between cemento-enamel junction and the bone crest using an electronic digimatic caliper (EDC) under a 10X magnified radiographs using DSRIA before and after periodontal therapy.

The results showed that: 1) in the absence of periodontal therapy, sites with more advanced attachment loss are more likely to undergo further breakdown than sites which have less attachment loss; 2) patients with a periodic recall (3-4 times/yr.) showed a significantly lower loss rate than patients without periodic recalls; 3) mean CRPAL was highest in the generalized aggressive periodontitis (GAgP) group (5.52±3.27 mm), then the chronic periodontitis (CP) group (4.82±3.47 mm), and the localized aggressive periodontitis (LAgP) group (4.47± 3.47 mm) followed, and lowest in the periodontal healthy (PH) group (1.05±0.59 mm); 6) mean ARPAL was highest in the LAgP group (0.26± 0.25 mm/yr.), then the GAgP group (0.20±0.13 mm/yr.), and the CP group (0.12±0.09 mm/yr.) followed, and lowest in the periodontal healthy group (0.07±0.06 mm/yr.). The conclusions revealed that irrespective of periodontal disease group, results showed a periodic recall showed a significantly lower loss rate.

Keywords: CRPAL; ARPAL; DSRIA; Periodontitis; Sandwich's Technique

Abbreviations: CRPAL: Cumulative radiographic periodontal attachment loss; ARPAL: Annual radiographic periodontal attachment loss; EDC: Electronic digimatic caliper; GSgP: Generalized aggressive periodontitis; CP: Chronic periodontitis; LAgP: localized aggressive periodontitis; PH: Periodontal healthy; MPAL: Mean periodontal attachment loss; PD: Probing depth; RPP: Rapid progressing periodontitis; GJP: Rapid progressing periodontitis; LJP: Localized juvenile periodontitis; IPAL: Initial periodontal attachment loss; DSRIA: Digital scanning radiographic image analysis; EDC: Electronic laser scale; CEJ: Cementoenamel junction; CRPAL: Cumulative radiographic periodontal attachment loss; DEDC: Digital electronic cursor micrometer; DECM: Digital electronic cursor micrometer; EDC: Electronic digimatic caliper; EOP: Early onset periodontitis; IPAL: Intermittent periodontal attachment loss

Introduction

A three-year study presented by Suomi et al. that adults aged 18 to 40 years showed that adults receiving frequent oral prophylaxis and oral hygiene guidance had a rate of contiguity loss of 0.03 mm/yr [1]. Adults who maintained their original oral hygiene habits and their original visits had a relatively higher rate than frequent returns, at a rate of 0.10 mm/year. Therefore, patients who receive frequent return visits and professional preventive treatment and health education have a low rate of mean periodontal attachment loss (MPAL) from 0.03 to 0.1 mm/yr. relative to the number of return visits. Frequency of return visits and rate of MPAL showed that patients received 3 to 4 recalls per year during a five-year observation period, and the rate of loss of buccal attachment was 0.09 to 0.14 mm/year [2]. Rosling et al.

[3] pointed out that patients with severe periodontal disease who had undergone periodontal surgery were scheduled to return to preventive treatment every two years and found that the loss rate was 1 mm/yr., nearly ten times more than the general statistical value.

The results of a Swedish's study of MPAL by Axelsson and Lindhe [4] on untreated periodontal disease found that the MPAL for patients younger than 35 years of age was 0.1 mm/year and 0.3 mm/year after age 50. Their results showed that with the increase of age, more teeth had the phenomenon of loss of periodontal attachment. The MPAL also shows a steady and continuous increase with age. However, the periodontal destruction rate did not increase significantly due to age. Loe et al. used periodontal probing method to conduct a six-year study of periodontitis in 565 healthy men aged 17 to 30+ years in Norway who were students or graduate students, and 480 tea pickers aged 15 to 30+ in Sri Lanka [5]. The statistical results found that the MPAL of 17-year-old adolescents in the Norwegian group was 0.06 mm. Where there was 0.98 mm for adults aged 31 and 1.66 mm for adults over 37 years and before 40 years; In the Sri Lanka group, the average associated loss was 0.17 mm for 15-year-olds, 3.11 mm for adults aged 31, which was much higher than in the Norwegian group, and the loss of attachment before the age of 37 and 40 was as high as 4.50 mm. The results also showed that the MPAL in the Norwegian group was around 20 years old, with a proximal surface of 0.05 mm/yr. and a buccal surface of 0.1 mm/year; by the age of 40, the proximal surface is 0.08 mm/year and the buccal surface is 0.1 mm/year. The average was 0.25 mm/year in the Sri Lanka group before the age of 20 and 0.30 mm/year after the age of 20 [6].

Most of these studies were focus on the MPAL of single age groups and different races. In addition, all of their studies on the materials and methods were periodontal probe, ADA x-ray with 5x-10x magnified viewer in cases affected untreated adult periodontitis before 1996 [5-8]. Machtei et al. [7] used electronic periodontal exploration to classify the probing depth (PD) of each tooth position into shallow (0 to 3.9 mm), medium (4 to 6.9 mm), and deep (7 mm) for 51 untreated periodontal disease patients. During the one-year observation period, it was found that the average attachment loss of the original pocket depth was 1.03 mm, which was significantly greater than the 0.34 mm in the middle and 0.1 mm shallow ($p< 0.001$); the average loss for all patients was 0.2 mm. The conclusion shows that when PD (7 mm), the speed and depth of clinical periodontal attachment loss will be greater in the future. Thus, deeper pockets, especially at PD (7 mm), are at higher risk of further loss of attachment in the future.

In the study of Machtei et al. [7], no statistical difference was found between the mean annual loss of 0.21 mm of molars and 0.20 mm of non-molars in untreated patients affected periodontitis ($P=0.08$). And the percentage (8.0 %) of loss sites produced by molars is similar to (8.5 %) of non-molars. However, of all loss sites, the average loss of molars (2.7 mm) is much greater than that of non-molars (1.89 mm) ($p< 0.0001$). The above shows that molars are not more susceptible to MPAL than non-molars, but these molars seem to progress faster than non-molars once they are destroyed into active stages. Molars and incisors, especially incisors, are the types of teeth with the highest incidence and the fastest destruction rate. This is true in all three groups, while the GJP group is less significant. The typical molar-incisor configuretion pattern in LJP becomes less pronounced with age [9]. The progression of LJP and GJP is similar, mainly in the shape and number of teeth that produce attachment loss. Many LJPs, especially some untreated patients, may become GJP within six years, and time is an important factor. In addition, Löe et al. [10] reported that the average annual rate of attachment loss among young (14-19 years old) Sri Lanka tea pickers was 0.05 mm/yr. in moderate progressive periodontitis, similar to 0.08 mm/yr. in the LJP group; The annual failure rate of rapid progressing periodontitis (RPP) was 0.13 mm/year., which was similar to 0.18 mm/year in the GJP group. Brown [8] observed 91 U.S. adolescents aged 13 to 20 with EOP for up to six years. Results showed that the fastest mean of annual periodontal attachment loss (ARPAL) was in the generalized juvenile periodontitis (GJP) group (0.18 mm/year), followed by the localized juvenile periodontitis (LJP) group (0.08 mm/year), and initial periodontal attachment loss (IPAL) group (0.02 mm/year). Little or limited literatures regarding the CRPAL) and ARPAL among Taiwanese's individuals with GAgP, LAgP, CP, and PH groups is available. The purpose of the present study was to investigate the CRPAL and ARPAL among Taiwanese's individuals with GAgP, LAgP, CP, and PH groups.

Materials and Methods

A total of 53 subjects, who had taken two sets of full mouth standardized paralleling radiographs with separated periods of 5 years or more during 1981-2001. Patients affected with periodontitis reported or referred to periodontal department of Kaohsiung Medical University Hospital were collected for the past 20 years. The study was conducted investigate and evaluated correlating factors such as CRPAL and ARPAL rates, tooth location, tooth mobility which could influence the clinical characteristics and course. The subject population of the present study was limited to the untreated patients of PH group and cases affected with CP, LAgP and GAgP, who never had previously received periodontal therapy. The periapical radiographs were taken by the parallel technique and XCP film holders with long cone indicator. All the scanned radiographs were displayed on a PC monitor under a 10X image enlargement and measured by the computer system. The ARPAL at the mesial and distal surfaces were calculated at 10X magnifycation for CRPAL and ARPAL using the digital scanning radiographic image analysis (DSRIA) [11]. Table 1 collect collected samples of 53 patients according to the classification criteria of the international workshop for a classification of periodontal diseases and conditions at the end of 1999 [12]. Classification criteria for periodontal disease and periodontal variation, including patient

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age, alveolar bone loss, type of bone loss, number of teeth involved, location of teeth involved, etc., were diagnosed as CP, GAgP, LAgP, and periodontal healthy PH groups. Medical University from 1981 to 2001, including 29 males and 24 females, aged 20-66 years, with an average age of 37.70 ±11.58 years. The X-ray image is magnified by a 10x magnifier, and the digital electronic laser scale (EDC) measures the CRPAL and the length of the CRPAL of each tooth (except for the third molar) to calculate the CRPAL and the length of the tooth root of ARPAL.

Table 1: The difference of mean CRPAL (mm) at Periods A、B and C by different periodontitis types. (CP:n=14; GAgP: n=20; LAgP: n=9; PH:n=10).

Dis. type	N	n	Period A	Period B	Period C	Significance
			Mean (SD)	Mean (SD)	Mean (SD)	
CP	14	394	- 4.82 (3.47)	- 0.30 (1.17)	- 3.94 (2.06)	****
GAgP	20	566	- 5.52 (3.27)	- 0.38 (1.85)	- 4.77 (2.73)	****
LAgP	9	268	- 4.47 (3.47)	- 0.47 (1.52)	- 3.53 (2.21)	****
PH	10	457	- 1.05 (0.59)			
	53					
Significance			****	p=0.3509 (NS)	****	

N: indivisuals; n: number of sites; CP, N=14; GAgP, N=20; LAgP, N=9; PH, N=10); NS: not significant (p >0.05); Significant: *p <0.05, **p < 0.01, ***p <0.001, ****p<0.0001

Measurements of ARPAL using DSRIA [11]

Proximal RABL was defined as bone defects of at least 2 mm distance between the CEJ (point A) and the alveolar bone crest (point B).Deeper defects were recorded as the % of the ratio of RABL to root length. The radiographic CEJ (point A), alveolar bone crest (point B) and root apex (point C) were used as three reference points for calculating RABL. The co-ordinates generated by the MIS [11]. The study of the mother group diagnosed with CP, GAgP, LAgP and PH groups and had received two routine full-mouth X-rays with an interval of more than 5 years, except for periodontitis, the patient was clinically healthy, had no systemic disease, and had periodontal tissue destruction, including rapid loss of attachment and alveolar bone destruction. A total of 29 individuals according to the type and number of invading teeth, it is subdivided into: localized aggressive periodontitis (LAgP; 9 patients; 6 males, 3 females) (at least 2 permanent teeth: molar and anterior teeth) has periodontal attachment loss, one of which is the first molar. Except for the first molar and incisors, no more than 2 teeth have been violated, counting 9; generalized aggressive periodontitis (GAgP; 20 patients; 9 males, 11 females) (at least 3 permanent teeth of non-first molars and incisors with contiguous loss), counting 20.

From the study mother group diagnosed with CP, a total of 14 patients (males 10; females 4) who had received two routine full-mouth periapical radiographys spaced more than five years apart were taken. Most of them occurred in adults, and the amount of periodontal tissue destruction was consistent with local factors, showing a moderate to slow rate of destruction, and the samples were free of systemic disease. Collected 10 periodontal health (PH; 10 patients; 4 males; 6 females) routine full-mouth periapical radiographic examination (14 photos) of PH with healthy periodontal condition of evaluation results, which met the standard parallel photography, and no one interpreted the effect of flushing stains. The screening principle for periodontal health is that the distance from the full mouth CEJ to the alveolar crest is not more than 3 mm, and there is no missing area (excluding the third molar), which is used as a control group (PH; 10 individuals; 4 males; 6 females) for this study. After the measurement and analysis, the patients in the experimental group were classified as a percentage of the root length of the root of the tooth according to the radiographic periodontal attachment loss (RPAL; %); and listed as follows: mild: RPAL<30%, moderate: RPAL = 30%□50%, and severe: RPAL >50%. The mean and standard deviation (SD) and loss rate of each disease group were calculated.

1. **Point A**: The cementoenamel junction (CEJ of the tooth bone at the baseline is designated as point A.

Boyle [13] found that the knife-edge image of the CEJ appearing near the far center of the tooth on dental radiographic image corresponds to the mid-facial-lingual of the actual tooth, which is the CEJ at the proximal position. If the CEJ is unambiguously identifiable due to overlapping images at the time of shooting or due to the presence of calculus, decay, large restorations or prosthesis, it is considered unmeasurable and is not included in the research calculations (Figure 1).

2. **Point B**: from the first to the second dental radiographic taking.

3. **Point C**: Root apex, designated as point C.

Set the AB distance as cumulative radiographic periodontal attachment loss (CRPAL); Set the AC distance to radiographic root length. In this study, DSRIA [11] will be used to calculate the

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ARPAL by dental periapical radiographs. The time to be studied is also divided into three stages, including Period A (complete formation of tooth roots to the first dental radiographic taking), Period B (from the first to the second dental radiographic taking), and Period C (complete formation of tooth roots to the second dental radiographic taking), respectively, calculating the annual radiographic periodontal attachment loss rate (ARPAL) during the three Periods A, B, and C (Figures 2a-c). However, the periodontal health group only had its first dental radiographic taking, so it only contained Period A.

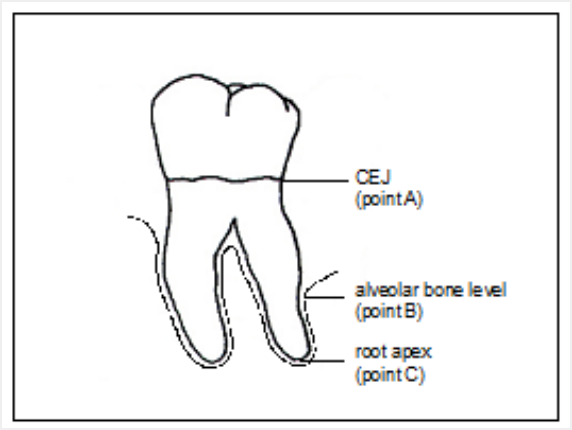
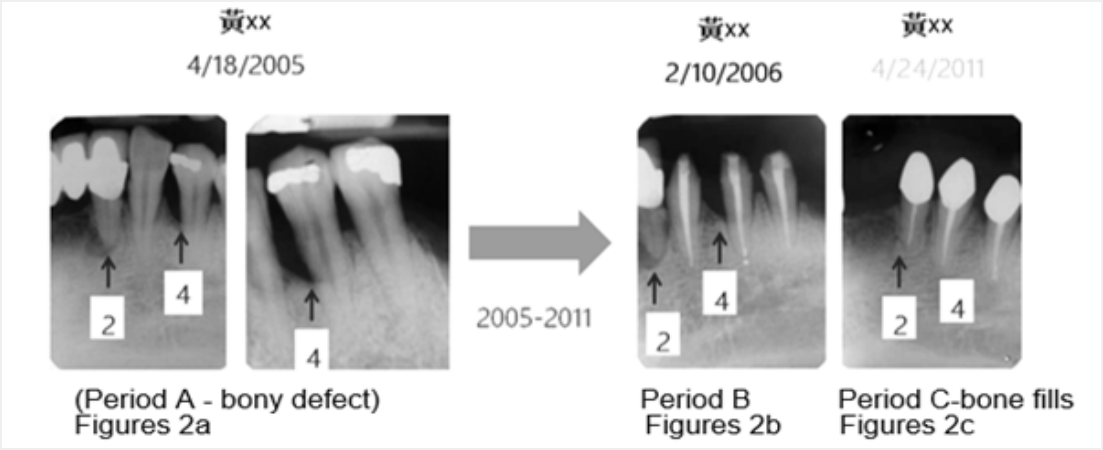


Figure 1: RPAL= (AB ÷ AC) × 100.



Figures 2a-c: Periodontal bone healing from Period A (baseline), Period B and Period C (final healing).

All of the above measurements are excluded from the calculation if:

i. CEJ is illegible due to dental calculus, decay, restoration, or overlapping images;

ii. If the researcher believes that the image deformation is severe and affects the assessment of the height of the alveolar bone, it is considered to be impossible to measure. The above measurement records were all done by the same person.

Results

Table 1 illustrated the difference of mean CRPAL (mm) at the Periods A, B and C by different periodontitis types of CP (n=14), GAgP (n=20), LAgP(n=9) and PH(n=10). The mean CRPAL (mm) the CP group was -4.82±3.47mm, the GAgP group was -5.52±3.27mm, the LAgP group was - 4.47± 3.47mm and the PH group was -1.05±0.59mm at the Periods A. The highest mean CRPAL was the GAgP group with -5.52±3.27mm, the second was the CP Group with -4.82±3.47mm, and the least was the LAgP with - 4.47± 3.47mm, respectively. The statistical analysis showed a strong significance ($p<0.0001$) among the different periodontitis types of CP, GAgP, LAgP, and PH groups at the Periods A stage of baseline. The difference of mean CRPAL (mm) at the Periods B, by different periodontitis types of CP, GAgP and LAgP after periodontal treatment of Sandwich's technique (14) from the first to the second dental radiographic taking. The differences of mean CRPAL (mm) were -0.3±1.17mm, -0.3±81.85mm and-0.47±1.52mm among the CP, GAgP, and LAgP groups. There is no

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statistical significance (p<0.3509) among the difference of mean CRPAL (mm) at the Periods B by different periodontitis types of CP, GAgP and LAgP after periodontal treatment. It means that the treatment effect is similar to that of different periodontitis types of CP, GAgP and LAgP. The difference of mean CRPAL (mm) at the Period C among different periodontitis types of CP, GAgP and LAgP after the final clinical evaluation of periodontal treatment using the Sandwich's technique. Results indicated that the decrease of mean CRPAL (mm) from the baseline data of mean CRPAL(mm) to -3.94±2.06mm,- 4.77±2.73mm and - 3.53±2.21mm. The statistical analysis showed a strong significance (p<0.0001) among the different periodontitis types of CP, GAgP, LAgP groups at the Periods C stage. This means that the remarkable improvement of mean CRPAL reduction after long-term clinical evaluation among different periodontitis types of CP, GAgP and LAgP after periodontal treatment.

Table 2 illustrated that the annual mean (SD) of ARPAL in patients among the periodontal disease groups of the CP, LAgP, and GAgP groups in the Period A were -0.12± 0.09mm/year, -0.22±0.16 mm/year, and -0.23±0.24 mm/year, respectively; Each group of the CP group, LAgP group, and GAgP group was statistically verified and found that revealed a statistically significant differences(p<0.0001) as compared to the PH group with -0.07±0.06 mm/year (Table 2). The annual mean (SD) of ARPAL in PH group had only one dental radiography, so only Period A was measured. The mean (SD) of ARPAL of PH group was -0.07±0.06mm/year. Statistically verified each group found statistically significant (p<0.0001) differences among the groups of the CP, GAgP and LAgP groups as compared to the PH group (Table 2). Follow-up periods during the first dental radiographs to the second dental radiographs during Sandwich's therapy. The annual mean (SD) of ARPAL in patients with CP, GAgP, and LAgP groups in Period B were -0.04±0.18mm /year, -0.08±0.29 mm/year, and -0.05±0.21 mm/year, respectively. Statistically verified each group found statistically non-significant (p=0.3509) differences among the groups of the CP, GAgP and LAgP groups as compared to the PH group.

Table 2: The difference of mean ARPAL (mm/yr.) in period A、B and C by different periodontal disease types.

Dis. type	N (n)	Period A	Period B	Period C	Significance
		Mean (SD)	Mean (SD)	Mean (SD)	
CP	14(394)	- 0.12 (0.09)	- 0.04 (0.18)	- 0.09 (0.05)	****
GAgP	20(566)	- 0.22 (0.16)	- 0.08 (0.29)	- 0.14 (0.09)	****
LAgP	9(268)	- 0.23 (0.24)	- 0.05 (0.21)	- 0.12 (0.08)	****
PH	15(457)	- 0.07 (0.06)			
Significance		****	p=0.3509 (NS)	****	

N: indivisual; n: number of sites; Dis.: Disease; CP, n=14; GAgP, n=20; LAgP, n=9, ph=15); NS: not significant (p >0.05) Significant: *p <0.05, **p < 0.01, ***p <0.001, ****p<0.0001

The Period C indicated that the annual mean (SD) of ARPAL in patients with CP, GAgP, and LAgP in this study were -0.09±0.05 mm/year, -0.14±0.09 mm/yr., and -0.12±0.08 mm/year, respectively Each group was statistically verified and found to have statistically significant (p<0.0001) difference among periodontal disease groups as compared to the PH group, respectively (Table 2). Table 3 The changes of cumulative and annual radiographic periodontal attachment level (CRPAL, mm; ARPAL, mm) of teeth at the treatment stages of the Periods A, B, and C in the periodontal health and disease types. Table 3 presented the changes of cumulative and annual radiographic periodontal attachment level (CRPAL, mm; ARPAL, mm) of teeth at the treatment stages of Periods A, B, and C in the periodontal health and disease types. The treatment of Period A with 1228 teeth at the baseline with a mean (SD) of -5.06±3.40 mm of CRPALs at the baseline.

Table 3: The changes of cumulative and annual radiographic periodontal attachment level (CRPAL, mm; ARPAL, mm) of teeth at the treatment stages of the Periods A, B, and C in the periodontal health and disease types.

Treatment stages	N	CRPALs (mm)	ARPALs (mm)
		Mean (SD)	Mean (SD)
Period A	1228	-5.06(3.40)	-0.19(0.16)
Period B	1015	-0.37(1.58)	-0.06(0.24)
Period C	1015	-4.24(2.48)	-0.12(0.08)
Significance		p <0.0001	P<0.0001

N: teeth number; Significance: *p<0.05; **p<0.01; ***p<0.001; ****p<0.0001.

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The Period B with 1015 teeth with a mean (SD) of -0.37±1.58mm of CRPAL indicated that the mean (SD) CRPAL from the first to the second dental radiographic taking from the first to the second dental radiographic taking. It also indicated that the decreased mean (SD) CRPAL was -0.37±1.58 mm with the mean of ARPAL -0.06±0.24 mm of each year improvement after periodontal treatment. The Period C with 1015 teeth with a mean (SD) of -4.24±2.48mm of CRPAL means that the complete formation of tooth roots to the second dental radiographic taking. It also indicated that final clinical evaluation of periodontal treatment from the baseline to final results was improvement of CRPAL and ARPAL with -5.06±3.40 mm and -0.19±0.16mm decrease to -4.24±2.48mm and -0.12± 0.08mm, respectively. Result of the treatment stages of among the Periods A, B, and C using the statistical analysis also showed the remarkable significance ($p<0.0001$) for both CRPAL and ARPAL [14].

Discussion

Schei ruler demonstrates the ratio of alveolar bone height to root length, that is, the percentage of alveolar bone height/root length to counteract the effect of image enlargement or reduction [15]. Most scholars of periodontal epidemiology [16-18] used methods similar to the Schei ruler [15]. The traditional Schei ruler has only five or ten lattices, that is, a lattice represents 10% or 20% of the amount of bone change, and this grading method reduces the sensitivity of this method, because the amount of destruction of the alveolar bone must be 10% or 20% to be calculated, and the precision is poor. In this experiment, the digital electronic cursor micrometer (DEDC) is used, with a minimum indication amount of 0.01 mm and an accuracy of ±0.02 mm, which greatly improves the sensitivity of the measurement. Coupled with a concept similar to the Schei ruler [15] also known as image magnification analysis, [19-22] it is an indirect proportional method, which uses the height of the alveolar bone loss as a percentage of the total root length (%) to express the loss of periodontal attachment height, and the root length of the tooth as a reference for the loss of alveolar bone can compensate for the difference in root length caused by individual, sex, different teeth and near-distal side. The advantage of this method is that by dividing the molecule and denominator, the amplification or reduction effect caused by the angle deviation of the x-ray exposure time beam (such as: foreshortening, elongation) can be minimized, so that the continuous change of the proportion of alveolar bone loss can be measured, the accuracy of this method is high, and the error is also small, and it is believed that the long-term assessment of the height change of the alveolar bone in patients with periodontal disease can provide a more objective observation.

Since radiographic measurement can measure the relative percentage of alveolar bone loss and root length, while periodontal detection can only measure the depth of periodontal attachment loss. It is impossible to know the relative loss of the tooth root length, and there is no stable reference point, which is not reproducible. This study hopes to serve as a baseline for long-term follow-up surveys in the future, so it is necessary for the data to be reproducible and permanent. Therefore, using the dental radiographic x-ray analysis method with permanent data source characteristics and using a more accurate digital electronic cursor micrometer (DECM) measurement. It is possible to record the linear length (mm) of radiographic periodontal attachment loss and calculate the ratio of radiographic periodontal attachment loss to root length (%). Due to the high accuracy and small error, the long-term assessment of the percentage of periodontal destruction can obtain more objective results, and it is believed that long-term epidemiological studies of periodontal bone destruction can provide a more accurate method.

This article uses the method of electronic digimatic caliper (EDC) to measure the change of dental RPAL. Which is similar to the research purpose of RPAL of various types of periodontitis counted by the magnification analysis method of dental periapical radiographic image in the past. First of all, we use ARPAL, it means annual to make a comparison. Norwegian investigator, Dr. Albandar [23] measured the change of radiographic alveolar bone over a two-year period for 180 patients affected adult periodontitis by enlarging the two radiographic x-ray images 10 times before and after, and then depicting the shape with 10 times the magnification of transparent checkered paper, measuring the distance from CEJ to the alveolar crest, and the average annual mean of RABL was -0.11 mm/year. Papapanou [24] also observed 283 adult patients with periodontitis for 10 years by measuring the previous and subsequent dental radiographic images and the results were from -0.07mm to -0.28 mm/year. The results of this study in patients with CP are from -0.08 to -0.25 mm/year with a mean of -0.09±0.05 mm/year, similar to the results observed by the former two scholars. In addition, Brown [8] observed 91 American adolescents aged 13 to 20 with early onset periodontitis (EOP) for 6 years, using periodontal probes to probe the height of periodontal attachment. Results showed that the fastest rate of periodontal attachment loss was in the generalized juvenile periodontitis (GJP) group (0.18 mm/year), followed by localized juvenile periodontitis (LJP) group (0.08 mm/year), and the intermittent periodontal attachment loss (IPAL) group (0.02 mm/year). In this article, Period A, the mean of ARPAL in the LAgP was 0.23 mm/year and GAgP was 0.22 mm/year. Similarly, the CP group was again 0.12 mm/year, and the PH group was the lowest (0.07 mm/year).

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